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To Mr Russell Field from the Author

ON THE

FOSSIL FOOT-MARKS

IN THE

RED SANDSTONE OF POTTSVILLE,

PENNSYLVANIA,

BY

ISAAC LEA,

MEMBER OF THE AM. PHIL. SOC.; OF THE ACAD. OF NAT. SCIENCES OF PHILADA.;
OF THE ZOOL. SOC. OF LONDON; OF THE IMPERIAL
SOC. OF MOSCOW, &C. &C.

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1852.

ON THE FOSSIL FOOT-MARKS

IN THE RED SANDSTONES OF POTTSVILLE.*

WHEN I communicated to this society, in 1849, the discovery of "foot-marks" of a Saurian animal in the "red shale" formation, No. 11, of Prof. H. D. Rogers, near Mount Carbon, south of Pottsville, I mentioned that in characterizing and naming this new animal (*Sauropus primævus*), I would at a future time offer to the society a more lengthened and accurate description, with correct figures of this remarkable and interesting specimen. A subsequent visit to the locality has not induced me to change my views as to its position in the series of the stratified masses of that district.

After the discovery of this ancient Saurian had been made known, by my account of it in the Proceedings of this society, Prof. H. D. Rogers stated, at the meeting of the "American Association for the Advancement of Science," at New Haven, that these "foot-prints in the red shale formation at Mount Carbon" were "of an age essentially later than that attributed to them,"—that "they occurred in a geological horizon only a few hundred feet below the conglomerate which marks the beginning of the productive coal series, in which series similar foot-prints, attributed to batrachian reptiles, have been previously met with in Western Pennsylvania. Instead, therefore, of constituting a record of antique reptilian life, earlier than any hitherto discovered, by at least a whole chapter in the geological book, they carry back its age only by a single leaf."

These and some farther observations were followed by remarks of Prof. Agassiz on the character of these foot-prints, which he attributed rather to "the pectoral and ventral fins of fishes of an ancient type, which probably had some power of locomotion out of water."†

At the meeting, in August, 1851, at Albany, Professor Rogers exhibited specimens which he had procured from the same formation, (No. 11,) near to the same locality.

[* Read before the American Philosophical Society, April 2d, 1852, and published in the Transactions, Vol. X., New Series.]

† Proceedings of the American Association, 1850, p. 251.

These consisted of some of the same kind of "foot-prints, with others of a very different form, and these were accompanied by more perfect specimens of impressions of plants than had before been discovered. These were of great interest, as their structure indicated their being "air plants." The Professor named them *Plumites*. He also mentioned that he had found *Stigmaria* in the "red shale" of formation No. 11. Prof. Agassiz subsequently remarked on these tracks, and objected to any of them being considered as made by "reptiles." He did not believe that any of them were made by air-breathing animals; that these "trails" could not be made by "reptiles," but that they must have been made by "annelids or fish," and most probably by "*Articulata*." He farther stated that in his belief no air-breathing animal had been found even as low as the New Red Sandstone.

Without disputing such authority as that of Prof. Agassiz, I shall hold to my own opinions, as expressed in my former communication, as to the fact of these "foot-marks" being impressed by a four-footed, air-breathing animal, allied to the "Saurians," having four toes on the hind foot and five on the fore foot. As regards the opinion of there having been no air-breathing animals in existence as low as the New Red Sandstone, it appears to me to be fully answered in the negative by the existence of the *Chirotherium*, (*Labyrinthodon*, Owen,) *Thecodontosaurus*, &c., in that formation in Europe, and by the recent discovery of the bones and teeth of a *Sauroid* animal in the New Red Sandstone of Lehigh county, Penna., announced by me in the Proceedings of the Academy of Natural Sciences, last year, and which I named *Clepsysaurus Pennsylvanicus*.

As regards the observation of Prof. Rogers, that the "foot-prints" at Mount Carbon were "of an age essentially later than that attributed to them" by me, I would reassert that what I then stated was correct, that is, that they existed in his "red shale formation," No. 11, of his Pennsylvania survey. There is no error, as implied by Prof. Rogers' communication, in this fact; the position of the "foot-marks" is undeniable. The difference is simply whether formation No. 11 be part of the "*Old Red Sandstone formation*" or not. It was my opinion, with that of most of our geologists, that in the Pennsylvania Reports, when the term "red shale formation," No. 11, was used to designate a "period" two "formations" below the coal measures, (For. 13,) the *Old Red Sandstone*, analogous to that of Europe, was considered to be understood.* The late Richard C. Taylor, whose authority, on the geology of this state was inferior to none other, was said by Prof. Silliman, Mr. Hall and others, to have been the first person in this country who had referred the Old Red Sandstone underlying the coal of this state, to its true position, correspond-

* The position of Prof. Rogers' "red shale formation," (No. 11,) is thus described by him:—"A very brief description will, for the present, suffice to designate the range of the red shale formation. Encircling in a continuous zone all the anthracite coal basins of the state, it usually constitutes a chain of deep and narrow valleys enclosed between the ridges of Formation No. X. on the one side, and on the other, those containing Formation No. XII., composing the margin of the coal measures."

"The maximum thickness of this formation occurs, apparently, in its south-eastern belt, or that which ranges along the south side of the southern anthracite coal basin. From accurately conducted measurements made at Pottsville, the depth of the stratum at that place is about 2,949 feet."—*Second An. Report*, p. 66.

"Formation No. XII." he designates as "conglomerates and sandstones immediately below the coal measures of the Anthracite, the Broad Top and the Allegheny coal regions," which, at Pottsville, he makes 1031 feet.

ing with its place in the series of European rocks; and Mr. T. always considered For. No. 11 as the "*upper series of the old red sandstone*." In his paper on the "Carboniferous Series of the United States," (Mag. of Nat. Hist., vol. 9, 1836,) he makes the Old Red Sandstone which underlies the coal formation of Pennsylvania, equivalent to that in Europe. He does not agree with Mr. Weaver in his views regarding this red sandstone. Mr. Taylor arranges these rocks thus:—

1. The (almost) horizontal carboniferous series. This includes the conglomerate on which the series is unquestionably based.

2. "The Old Red Sandstone and Red shales, many thousand feet thick,"—nearly vertical, in central Pennsylvania—pass immediately beneath the bituminous coal field of Pennsylvania, in Tioga county.

3. The upper transition and grauwacke series commences at the termination of the red shales and sandstones.

He states that the "diagrams which have been laboriously worked out, exhibit no limestone in Pennsylvania between the secondary coal series and his Old Red Sandstone group, which average a mile thick." And again he says, "I see that both in the acknowledged secondary bituminous coal region, and in those of the anthracite districts, the carbonaceous deposits are alike based on red sandstones and red shales."—Always considering these red sandstones as equivalent to the *Old Red Sandstone* of Europe.

In the New York reports, Mr. Hall considers "No. 11 of the Pennsylvania Survey" as equivalent to the "Old Red Sandstone," both of which he refers to the "Catskill group." (Part IV., Geology, p. 278.) In the diagram on the same page, he represents the *Old Red Sandstone* as immediately underlying the conglomerate which again underlies the "coal measures of Pennsylvania." In his annual report, 1840, p. 394, he says that "this rock (Old Red Sandstone) forms the limit between the Silurian and Carboniferous system, and may be regarded as one of the most important of the whole series;" and he gives Mr. Taylor the credit of pointing out the existence of this rock and its analogy to the Old Red Sandstone of Europe. In his geology, part 4, p. 516, he enforces this opinion by saying, "there remains no doubt but the sedimentary rocks of New York correspond with those of the Silurian and old red systems, as described in the *Silurian Researches*. If the Devonian is to be regarded as a distinct system, we shall find its representative in the Chemung and Portage groups, with, perhaps, a part of the Hamilton group." Mr. Conrad too, recognises the *old red system* in his table of Formations, and places the "Old Red Sandstone," of Blossburg, Penna., immediately above the Ludlow rocks of the Silurian system. (American Journal vol. 38, p. 89.) And in his report of 1841, when mentioning the Devonian group, he says, that "great tracts of this system lie between Carbondale in Pennsylvania, and the upper Silurian district of New York, nearly all of which is quite destitute of organic remains, except those of vegetables. (p. 42.) Dr. Emmons and Mr. Vanuxem seem, in their reports, to recognise the Catskill group as being analogous to the Old Red Sandstone of Europe, and that it immediately underlays the great coal formation of Pennsylvania. These inosculating strata have always presented difficulties to the geologist, and Mr. Vanuxem, when mentioning the differences of opinion, as to the

"coal formation" being classed with the transition or secondary rocks, says, "this has always been debateable ground. (N. Y. Reports, p. 13.) And farther on, when speaking of the coal-bearing rocks, he says they commence "at the top of the Devonian or the Old Red Sandstone and Catskill group." (p. 14.)

It was not until the meeting of the American Association of August last, that I was aware of there being a doubt in the mind of any American geologist of the Old Red Sandstone of Europe having its analogue in the United States. Professor Rogers then remarked, that he "did not admit the red sandstone of this epoch to be the *Old Red Sandstone* of Europe," and he denied that "the Old Red Sandstone existed in the United States at all." This opinion is at variance with that of all the American geologists, so far as I know, and that of the two most distinguished European geologists who have examined, with great care, the extended palæozoic strata of the United States, Verneuil and Lyell.* The latter, in his *Travels*, (vol. 2, p. 255, and in his *Map*,) makes the Tully limestone (No. 25,) the Genesee slate, (No. 26,) Portage group, (No. 27,) and Chemung group, (No. 28,) to embrace the Devonian period. And in another place he says, when describing the Tioga coal field, that "beneath the millstone grit are those red and gray sandstones already alluded to, as corresponding in mineral character, fossils and position with our "Old Red." (Vol. i., p. 62.) Verneuil embraces a wider extent for the Devonian, and begins it with the Oriskany sandstone, (No. 18,) and terminates with the Catskill group, (No. 29.) This wide range includes Formations 7, 8, 9, 10 and 11 of the Pennsylvania Survey. And in regard to the high authority of the palæontologist of the New York Survey, M. Verneuil says, "we have had occasion to recognise the exactness of the observations of this able geologist, and we only differ from him in opinion upon the age and the true equivalents of the black bituminous shales and of the principal mass of the micaceous sandstones which overlie them in the states of Ohio, Indiana and Kentucky." (Am. Journ., vol. v., p. 182.) Mr. Hall says, the Devonian system "comprises the five superior groups of the Helderberg division, the six groups of the Erie division, and the Old Red Sandstone." (Am. Journ., vol. 5, p. 366.) And he farther says, "It is incontestable that the red sandstone which forms its superior part, and which is so powerful on the frontiers of the states of New York and Pennsylvania, is upon the same horizon as the Old Red Sandstone of Scotland and Wales." (p. 367.)

* M. Verneuil, in his *Memoir "sur la Parallélisme des Dépôts Paléozoïques,"* places the Catskill group (which he designates as No. 28, but which is really No. 29 of Mr. Hall's Table,) in the Devonian system, and calls it "Vieux grès rouge." After his remarks on Nos. 26 and 27 of the New York Reports, he says, "Pour terminer cette revue rapide de la série paléozoïque de l'État de New York il ne nous reste qu'à dire quelques mots des masses puissantes de vieux grès rouge qui forment les montagnes de Catskill, et qui, se prolongeant le long de frontières de la Pennsylvanie pénètrent dans l'intérieur de cet État. . . ou l'on trouve quelquefois des fragments de poissons analogues à ceux du vieux grès rouge d'Ecosse et de Russie tels que l'*Holoptichus nobilissimus*." (page 17.)

The able palæontologist, Mr. Sharpe, who examined, compared and tabulated the palæozoic fossils taken from this country by Sir Charles Lyell, considers the Old Red Sandstone of the "New York system to close with the Chemung group, which is surmounted by a formation of sandstone, considered identical with our Old Red Sandstone." (Proceedings Geol. Soc., vol. 4, p. 155.)

I am not disposed to undervalue the difficulty which exists in dividing the carboniferous system from that which immediately underlies it. It is and has been "debateable ground." But in placing these Pottsville "foot-marks" in the "red shale formation, No. 11," and then considering, with many other geologists, that Formation No. 11 was the Devonian or upper portion of the Old Red Sandstone, it never occurred to me that the place of these "ancient foot-prints" could be converted into the appearance of a geological error, when I expressly stated they were found near Mount Carbon, in the "red shale Formation, No. 11," of Prof. Rogers. And when he says, that they "are of an age essentially later than that attributed to them," and but a few hundred feet below the conglomerate, (For. 12,) which marks the beginning of the productive coal series, in which similar foot-prints, attributed to batrachian reptiles, have been previously met with in Western Pennsylvania,* an erroneous impression has been made on the minds of geologists, that I had made a mistake in the geological position of the foot-marks, and it is to this point I wish to draw the attention of the geologist, viz., that I gave Prof. Rogers' own nomenclature to the rock, "red shales," ("Formation No. 11,") and stated it to be about 1730 feet below the coal formation, (No. 13,) which Formation according to his measurement, was 6750 feet thick at Pottsville. Taking, then, his measurement, I presumed these "foot-marks to be about 8500 feet below the upper part of the coal formation there." The very interesting "foot-marks" discovered by Dr. King, being near to the *upper portion* of the Coal Formation in the vicinity of Greensburg, Penna., are very essentially removed and later, by two Formations, according to the Table of Formations of Prof. Rogers himself, and must therefore carry back the existence of an air-breathing animal, not, as he stated, that "they carry back its age only by a single leaf," but by *two Formations*,—that is, from Formation No. 13 back to Formation No. 11, leaving the great conglomerate Formation No. 12, interposing its mass, 1031 feet, and descending below its lower limits 700 feet, into the "red shale," (For. 11.)

As to the difference of opinion between Prof. Rogers and the able geologists quoted above, regarding this "red shale formation," whether it be the equivalent of a part of the Devonian (upper portion of the Old Red Sandstone,) or not, it is a matter of little moment in this case. That is a question to be definitely settled when we get more palæontological evidences, and when we obtain more of the organic remains of this "*red shale*," (For. 11,) in which I was fortunate enough to have observed the distinct trace of the oldest "air-breathing animal," then known in the sedimentary rocks of the globe. Without more records of the organisms of existing life at the epoch of this "*Red Shale Formation*," assured analogies cannot be established; and a difference of opinion may reasonably exist at the present time, as to the equivalents of the masses in Europe with ours on this side of the Atlantic; but in the total absence of the Old Red Sandstone I should not concur with Prof. Rogers.†

* By Dr. King, in Formation 13.

† In regard to their line of division, Mr. Hall very judiciously remarks, that the separation between the carboniferous and lower deposits is far from being well defined, and not as well ascertained as the separation "between the Devonian and Silurian." (Am. Journal, vol. 7, p. 47.)

M. Verneuil considers that "if in two countries, a certain number of systems characterized by the same fossils, are superimposed in the same order, whatever may be the thickness or number of the physical groups of which they are composed, these systems should be considered as parallel and synchronous." (Geol. Soc. Proc., vol. 4, p. 103.)

I am aware that Prof. Rogers would arrange all the rocks, from the Potsdam sandstone inclusive, to the top of the coal rocks, in one "system," of about 30,000 feet in thickness, characterized by peculiar organic remains, marking a long series of events, and a vast lapse of time. He said, in his address of 1844, "we behold one uninterrupted succession of deposits, closely linked by an unbroken sequence of animal and vegetable remains;" that they "constitute a single system, the entire record of one immense continuous period, the collected gatherings of one prodigious sea." (Pages 19 and 20.)

In these views I should not be disposed to go to the entire length. I am aware that in Europe there is a great difference of opinion among the most able geologists. Sir Charles Lyell now repudiates the theory of "*successive development of organic life*," and advocates the wide field of "*uniformation*," which an able writer in a late Number of the London Quarterly Review has most vigorously attacked and apparently settled.

For the present it might be safest to view the divisions of the more ancient rocks as forming two systems—the older and newer Palæozoic rocks—and make the separation at the Devonian (old red sandstone,) including it in the newer Palæozoic rocks, which would then embrace also the Carboniferous Limestone, the Conglomerate, the Coal measures, and the Lower New Red Sandstone or Permian. The older Palæozoic rocks would embrace all the ancient sedimentary rocks below the Devonian. These are the views of Prof. Forbes and other geologists, and they seem to me to be more nearly in accordance with the present state of our knowledge of the strata and their organic contents.

Having, I trust, vindicated myself in regard to the geological position in which I had placed these remarkable "foot-prints," I shall proceed to regard some of their analogies, and then give a more extended and accurate diagnosis of the imprints themselves, than I did in my former communication, published in the Proceedings of this society, vol. 5, p. 91.

When Cuvier was engaged in fossil osteology, fossil *foot-prints* had not been observed; but he remarked that the print of a foot clearly indicated the form of the teeth and the bones which leave a mark. The first of these curious relics seems to have been observed in Scotland, by Dr. Duncan, at Dumfriesshire, in the *New Red Sandstone*. These were made, it is believed, by *tortoises*. Very shortly after this, the tracks of the *Cheirotherium* were observed, in Saxony, in the same formation, and Dr. Dean and Professor Hitchcock, in the *New Red Sandstone*, in the valley of the Connecticut river, observed various "foot-marks," nearly all of which they attributed to *birds*, some being of gigantic size. In 1836 Prof. Hitchcock published an account of these *Ornithichnites*, in the American Journal of Science, and many valuable papers have been published since by him, by Dr. Deane and others. The two most important ones are those in the Transactions of the American Academy, by Prof. Hitchcock, in vol. 3d, and by Dr. Deane, in vol. 4th. The Professor considered that he had made out forty-nine species, twelve of which were quadrupeds; four probably lizards; two Chelonians, and six Batrachians. The figures which he gives

of the genus *Anisopus* allies them to *Cheirotherium* and the figures of Dr. Deane, although evidently different, still have some analogy to the same genus.

These interesting discoveries had not long been made before the scientific world was informed of equally important quadrupedal imprints having been observed in the rocks of the Coal Measures, a Formation considerably lower in the series. In October, 1843, Sir Charles Lyell, in a paper communicated to the American Journal of Science, stated the fact that Mr. Logan had discovered in the "rippled marked sandstones" of Horton Bluff, Nova Scotia, "foot-steps which appear to Mr. Owen to belong to some unknown species of reptile, constituting the first indications of the reptilian class known in the carboniferous rocks," vol. 45, page 358. Von Meyer, early in 1844, added to the Fauna of the coal Formation a new reptile which he called *Apateon pedestris*, the complete skeleton of which he obtained at Münster-Appel, in Rhenish Bavaria. Towards the latter part of the same year, Dr. King, of Greensburg, Penna., published an account of the imprints discovered by him in Westmoreland county, in the sandstones of the Coal Measures, near to the surface of that formation, (No. 13, Penna. Survey.) This appeared in the Proceedings of the Academy of Natural Sciences, December 17, 1844. These "Foot-marks consisted of those of a bird and two "*Saurian reptiles*," and were stated to be "near 800 feet beneath the topmost stratum of the coal formation." These were subsequently visited and examined by Sir Charles Lyell, who considered them to belong to the genus *Cheirotherium*. Prof. Hitchcock described *Thenaropus heterodactylus* of Dr. King under the impression of its being Batrachian. The tracks, I think, were made by a Sauroid animal. Subsequently to these discoveries, in 1847, Prof. Von Dechen observed in the Coal Formation of the Saarbrück district several remains of a peculiar genus, which Dr. Goldfuss described under the name *Archegosaurus Decheni*, and at the same time stated that he considered it as "a crocodilian animal, forming a transition to the lizards, in consequence of the presence of a parietal foramen." After this, Dr. Goldfuss added two other species to this genus, *A. medius* and *A. minor*. The largest of the three, the *Decheni*, was supposed to be about three feet six inches long, and on a further examination he considered the genus to belong more to the *Labyrinthodonts*, (*Cheirotherium*), of the Trias than to the crocodiles. "The peculiarities of the skeleton correspond to those of the skin, which consisted of long, narrow, wedge-shaped, tile-like, horny scales, arranged in rows, which meet on the ventral side in *Archegosaurus Decheni* at right angles, in *A. medius* in a curve." Von Meyer considered that the *Archegosaurus* was nearly allied to the *Labyrinthodonts*, which Sir Richard Owen had considered as *Batrachians*. These Von Meyer was now inclined to believe were rather *Saurians*. It is said that Owen is lately disposed to consider the *Labyrinthodonts* as *Saurians* arrested in their development; page 55.* In January of the present year, a memoir on the discovery of fossil foot-steps by Captain Brickenden, and of a reptile, by Patrick Duff, Esq., and described by Dr. Mantell, was presented to the Geological Society of London. The specimen discovered by Mr. Duff was "a small four-footed reptile, not exceeding six or seven inches. A distinct impression of a

* M. Jager says that the *Pygopterus lucius* of Agassiz is not a fish, but a reptile, and the same as *Archegosaurus Decheni*. (Geol. Soc. Journal, vol. 7, p. 34.)

great part of the skeleton, with a mutilated portion of the cranium." Its osteological characters are said to be "peculiar, exhibiting a blending of the true lacertian with batrachian attributes." Dr. Mantell has named it *Telerpeton Elginense*. He also laid before the society specimens of fossil ova which he considered to be unquestionably ova of batrachian reptiles. (An. and Mag. of Nat. Hist., Jan., 1852.)

Impressions in the plastic clay and sand of the shores of ancient lakes or rivers, left by the inhabitants of their borders had been thus observed in the Coal Measures and the superimposed strata, as well also their bones. When, in April, 1849, on a visit to the coal district of Pottsville, Schuylkill county, Penna., I was fortunate enough to have observed the "Foot-prints," in bas relief, of a *reptilian quadruped*, in the Red Sandstones of the eastern slope of Sharp Mountain, where the river Schuylkill makes its pass through that range of mountains, an account of which I communicated to the American Philosophical Society in June, 1849. (See Proceedings, vol. 5, p. 91.) Its position was on the west side of the turnpike road, about a mile east of the town of Pottsville, and a few hundred feet east of Mount Carbon Hotel. The massive sandstone rocks here are of a beautiful red colour and fine texture, evidently formed of sand and clay which had passed through much attrition. The colour is due to a considerable charge of the red oxide of iron. Minute span-gles of mica are generally interspersed throughout these rocks, and assist in giving the surface of the fractures a soft and almost satin-like texture. The strata here are tilted somewhat over the perpendicular, by the upheaval of this range of mountains; but the surfaces which are exposed bear evidence of these sedimentary rocks having been deposited in a nearly horizontal position, in a placid state of water, presenting to the animal a very slightly inclined shore, as it advanced from the waters which existed on the northern side. The impressions made at that time were upon the sands of a shore from which the waters had for a time receded, having left the shore covered with well defined "ripple marks," and a profusion of "rain-drop pits." The surface of the rock exposed to view was about six feet by twelve, and across the shorter diameter were distinctly and beautifully impressed a double row of tracks, consisting of six impressions, duplicated by the hind foot falling into the impression of the fore foot, but a little more in advance. The specimen taken from the mass of the rock was thirty-four by twenty-one inches. The six *double impressions* show, in the two parallel rows, formed by the left feet on the one side and the right feet on the other, that the animal had five toes on the fore foot, three of which toes were apparently armed with ungual appendages. The hind feet appear to have had four toes. The impression of the hind feet being made nearly on the same spot as that of the fore feet, cause some obliteration and confusion, as well as variation in size and form of the "foot-marks." The best defined one is four and a half inches long and four broad—this is including the double impression. The single foot would probably measure three and a half inches long by three inches broad. The stride or step of the animal measures, from toe to toe, thirteen inches; from outside to outside, the distance is eight inches. The mark of the tail is distinctly impressed, causing a groove-like furrow on the top of each ripple line, oblique to their direction, and generally five to six inches long and three-quarters of an inch wide. There are four of these tail-

marks or grooves on as many ripple lines, the crests of which lines are elevated about half an inch above the intermediate depressions. The tail was evidently not a thick one, and the animal must have had a distinct and perfect step, and not a half swimming motion, as in the crocodilians, there being no trace of the dragging of the feet. The tail must have been considerably elevated, as the alternate tail-impressions show that a vibration actually took place at every step, the four grooves not being in a direct line, but each one approaching its nearest "foot-mark" to the right or the left, alternately, and therefore never precisely on the central line between the two rows of the foot-marks. These facts prove that the animal which left its imprint in this ancient sandstone stood much higher on its legs than the *Crocodylus* or the *Monitor*, and likely was not so long in proportion to the size of the feet. It is well known that the *alligator* leaves no foot impression in the mud, but simply a large furrow, made by the ventral and caudal portions. The form of the foot impressions are, however, very similar to that which is received by the mould in clay of the *Alligator Mississippiensis*, specimens of which are in the collection of the Academy of Natural Sciences of Philadelphia. If an opinion might be hazarded as regards the probable size of the animal, based on this meagre diagnosis, I should suppose it might reach as much as seven or eight feet in length.

The "ripple-marks," as observed before, covered the whole surface of the exposed part of the rock, six by twelve feet. Their crest-lines are generally seven or eight inches apart, and they swell up gently in nearly parallel lines, but falling off and recommencing again, give an irregular appearance to the surface, but which is altogether harmonious.

The "rain-drop pits" are rather large and nearly round, showing a tranquil state of the atmosphere when the rain descended. They covered the whole surface, and are not very deeply impressed.

In regard to the geological position of the "foot-marks" of this reptilian quadruped, having had no reason to doubt my former views, originally expressed in the Proceedings of this Society, I shall state it here nearly in the same words. The discovery was of great interest from the fact that no such animal remains had before been discovered so low in the series. Those described by Dr. King, in the great western coal-field, which naturally created great interest, are only eight hundred feet below the surface of the coal formation. (No. 13, of Prof. Rogers.) The position of the Pottsville "foot-marks" is about 8500 feet below the upper part of the coal formation there, which is 6750 feet thick, according to Professor Rogers, and they are in his "Red Shale Formation," (No. 11,) 2949 feet thick, the intermediate silicious conglomerate (No. 12,) being stated by him to be 1031 feet thick at Pottsville. These measurements would bring these foot-marks about seven hundred feet *below the upper surface* of this "Red Shale Formation," (No. 11,) which is the *Old Red Sandstone* of Mr. Taylor, Mr. Hall and other geologists of the New York Survey,* and now known as the Devonian of Sedgwick and Murchison. It has been well

* See R. C. Taylor "On the Carboniferous Series of the United States;" "Report of the Dauphin and Susquehanna Coal Company;" "Geological Chart of the Silurian Rock Formations of North America," MSS. 1847, in the Library of Acad. of Nat. Sci., &c., James Hall, "Geology of New York," Part 4, pp. 278, 516, &c., and other of these New York Reports.

known that this formation encircles entirely in a peculiar manner, all the three anthracite coal basins of Pennsylvania, and Prof. Rogers so describes it, stating that "it is enclosed between the ridges of Formation No. 9, on the one side, and on the other, those containing Formation No. 12, composing the margin of the coal measures." (2d Report, p. 66.) He describes "Formation No. 12," as "conglomerates and sandstones immediately below the coal," and states it to repose on the "Red Shale Formation," (No. 11,) p. 67.

A mass of coal plants exists immediately on the northern face of the heavy conglomerate, here tilted ten degrees over the vertical, and forming the crest and "back-bone" of Sharp Mountain. This conglomerate mass is about one hundred and fifty feet thick at the western side of the road, below Pottsville. On the same road-side, about 1735 feet from these coal plants, is the face of the rock bearing these "foot-prints," tilted slightly over the vertical, and facing the north. It is proper to state, that the limestone of the Old Red Sandstone exists here about two feet thick, and underlies these "foot-prints" sixty-five feet.

SAUROPOUS PRIMÆVUS. Pl. XXXI.

Feet pachydaetylous. Anterior ones armed with five toes. Divarications of the first and second toes = 60° ; of the second and the third, = 50° ; of the third and the fourth, = 40° ; of the fourth and the fifth, = 40° . Impression of the toes too much confused to measure correctly, varying from one and a half to two inches long. Length of the foot about three and a half inches. Breadth about three inches. Distance from the point of the first to the second toe, 1.9 inches; from the second to the third, 1.4 inches; from the third to the fourth, 1.2 inches; from the fourth to the fifth, 1 inch. Posterior feet armed with four toes. Divarications of the first and second, = 40° ; of the second and third, = 35° ; of the third and fourth, = 50° . Length of the toes not ascertainable, owing to their obliteration by its impact with the impression of the anterior foot. Track of the posterior foot in a line and directly in advance of the anterior foot. The stride or step from toe to toe, 13 inches; from outside to outside, 8 inches. Length of the tail-marks, about 5 inches; breadth, three-quarters of an inch.

PLATE XXXII.

This presents a reduced view of the slab, which is thirty-four by twenty-one inches, or rather less than one-fourth the natural size, and displays the regularity of the steps in a double row, as well as the librating tail-grooves, and the ripple-marks.

PLATE XXXIII.

In my former communication to this society, I mentioned that there were other remains of organized matter in this rock. Obscure impressions of plants, small spots, with filamentous radiations and reed-like marks had been observed. In many places on the surface of the rocks, I observed rough nodules, concretionary masses, which I have since concluded may be fossil ova of batrachian reptiles. They are irregular ovoid bodies, and usually in pretty close approximation. In the specimen before me, the water in passing over these left lines indicating its direction. (Fig. 2.) Occasionally may be seen small

subglobular forms, which may possibly be the ejectamenta or coprolites of some of the animals that passed over the shores of these waters.

Another of the specimens which I obtained at the same time, contains the remains of a portion of an organic form, which I cannot with any satisfaction make out. It is probably a very small portion of the whole organism, as it forms only a short, curved, serrated line of an inch and half in length. (Fig. 1.) I cannot compare this serrated line to any like form, but that of the serrated edge on the side of the *Olenus asaphoides*, of Hall's Palæontology, (part 4, pl. 67, fig. 2,) and *Asaphus Buchii*, in the Llandeilo Flags, (Silurian Syst., pl. 25, fig. 2,) in which the serrations are, however, more pointed. Mr. Hall's specimen is from the Hudson River Group, Formation No. 3, of the Pennsylvania Report, a period far removed and earlier than Formation 11, in which this specimen was found, near to Pottsville. The serrated edge of *Ellipsocephalus Hoffii*, Zenker, in Burmeister's "Organization of *Trilobites*," (p. 74, pl. 1, fig. 8,) approximates very closely, in outline, to our figure.

In 1834, Mr. Taylor communicated to the Geological society of Pennsylvania that he had observed "at least two nondescript species of *Fucoides* in the *Old Red Sandstone* of Tioga county, Pennsylvania." (Transactions, vol. 1, p. 175.) And he subsequently observed obscure impressions of plants in the same formation, near to Pottsville, at Tumbling Run Dam. This obscure vegetation has been observed also by others, and there are now specimens in the collection of the Academy of Natural Sciences of this city.

The red sandstone rocks of this period present frequent and marked instances of cracks caused by dessication of the mud which opens into irregular fissures, which, on return of the tide, were probably filled up by sand, thus sometimes furnishing a tissue of meshes of various sizes, the interspaces being sometimes as great as three feet. A very remarkable one of this kind may be seen at Dauphin, near the Susquehanna, above Harrisburg, in this red sandstone, underlying the coal measures of that part of the same basin. The surface of the rock exposed there with these sun-dried sand-cracks, must be quite thirty feet, and some of the cracks were nearly a foot across.



*Foot-marks of Sauropus primævus, Lea.
with ripple-marks and rain drop pits, -Size of nature*



*Six double foot-marks of Sauropus princeps, Lea.
rather less than $\frac{1}{4}$ size of nature*

1



2



1. *Uncertain Organic remains.*
2. *Probably Batrachian Ovipositor.*

Sinclair's Lith.





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